REMARKS

Claims 1-16 and 18-22 are currently pending. Claim 1 has been amended and claim 17 has been canceled to define Applicants' invention with greater particularity. No new matter has been added by this amendment. Support for this amendment may be found throughout the application as filed including, but not limited to, p. 12, lines 11-13. Applicants respectfully request reconsideration in view of the foregoing amendment and in view of the reasons that follow.

As a preliminary matter, Applicants' representatives thank the Examiner for courtesies extended in the telephonic interview of January 11, 2005. The rejections of record were discussed during the interview. The Examiner and Applicants' representatives disagreed as to whether the cited references (Ahmed et al. and Kumar et al.) disclose a method for generating hydrogen gas comprising the step of calculating the thermoneutral point according to the equation set forth in claim 1 prior to or during production of hydrogen. (Krumpelt et al.) In addition, the Examiner indicated that claim 1 "merely recites determining a thermoneutral point for the fuel prior to or during the production of hydrogen" does not require use of the equation recited in the claim. Applicants vigorously disagree and further point out that this basis for rejection was not cited in the final Office Action. It was, therefore, improper to raise this ground of rejection in the interview. Nevertheless, soley to expedite prosecution, Applicants have amended claim 1 to clearly recite the use of the recited equation for x_0 in determining the thermoneutral point.

I. Information Disclosure Statement

Applicants thank the Examiner for making of record the references listed in the Information Disclosure Statement submitted July 28, 2004. Applicants acknowledge that all of the references from the Information Disclosure Statements originally submitted August 3, 2001 and December 2, 2002 have now been made of record.

II. Rejection of Claims 1-20 based on 35 U.S.C. §103(a)

In the final office action mailed December 1, 2004, the Examiner rejected claims 1-20 under 35 U.S.C.§103(a) as allegedly unpatentable over Krumpelt (U.S. Pat. No. 5,929,286) in view of either Ahmed et al. ("Catalytic Partial Oxidation Of Hydrocarbon Fuels," hereinafter "Ahmed") or Kumar et al. ("The Low Temperature Partial Oxidation Reforming Of Fuels For Transportation Fuel Cell Systems," hereinafter "Kumar"). Claim 21 has been rejected as allegedly obvious over Krumpelt in view of Ahmed or Kumar and further in view of Collins (U.S. Patent No. 5,458,857). Claim 11 has been rejected as allegedly obvious over Krumpelt in view of Ahmed or Kumar, further in view of Collins and further in view of Ohata (U.S. patent No. 4,708,946). Applicants respectfully traverse these rejections.

Applicants first note that according to § 2142 of the M.P.E.P.,

> To establish a prima facie case of obviousness. Three basic criteria must be met. First there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure.

Applicants respectfully submit that a proper *prima facie* case of obviousness with respect to claims 1-20 has not been established. Krumpelt teaches a method of producing a H_2-rich gas from a fuel. Abstract. The reaction is to be run at an O_2:fuel molar ratio of less than or equal to n/2, where n is from the formula of the fuel, C_nH_m. Col. 3, lines 16-19. First, none of the cited references teaches or suggests all the claim elements. Contrary to the Examiner's assertion in Paragraph 3, Page 2, of the Office Action, the Examiner can point to no teaching or suggestion in Krumpelt that "the molar ratio of molecular oxygen supplied to the fuel processor per mole of fuel is x and has a value ranging from about $0.x_0$ to about $1.5\ x_0$." Moreover, despite the Examiner's reference to Col. 3, lines 16-19, Krumpelt certainly does not teach that x_0 is equal to

$0.312n - 0.5p + 0.5\ (\Delta H_{f,fuel}/\Delta H_{f,water})$. Krumpelt simply does not teach or refer to running the reaction at a point of thermoneutrality in any context.

Likewise, Ahmed also fails to teach that x has a value ranging from about $0.5x_0$ to about $1.5x_0$ and does not teach the use of the equation for x_0 set forth in claim 1.

Ahmed (p. 242) teaches the equation:

$$C_nH_mO_p + x(O_2 + 3.76N_2) + (2n - 2x - p)H_2O \rightarrow nCO_2 + (2n - 2x - p + m/2)H_2 + 3.76xN_2$$

where x is equal to the O_2:fuel molar ratio. Ahmed also teaches that the reaction should be run "at a low value of x" between x = 0 and x = 12.5. The reference does not specify what a low value of x, based on the O_2:fuel ratio, means and how that relates to the thermoneutral point described by the equation of claim 1, and derived from the ΔH value of fuel and water. This range encompasses a wide variety of values for x and is, at best, nothing more than an invitation to experiment.

Kumar teaches the point at which methanol reformation becomes thermally neutral from the equation:

$$CH_3OH + x(O_2 + 3.76N_2) + (1 - 2x)H_2O \rightarrow CO_2 + (3 - 2x)H_2 + 3.76xN_2.$$

Kumar also teaches that at a value of x = 0.23 the reaction is thermally neutral. Finally, Kumar teaches at the reaction should be run at a O_2:MeOH molar ratio that is "a little higher" than that of neutrality. Kumar fails to disclose Applicants' formula for the thermoneutral point, x_0, that this point should be determined before or during the partial oxidation reaction, or that x should be adjusted to about $0.5x_0$ to $1.5x_0$. Hence, it is clear that none of the references cited by the Examiner teach each of the elements of claim 1.

During the telephonic interview of January 11, 2005, with Applicants' representatives, the Examiner responded to these points by arguing "Kumar et al. and Ahmed et al. teach that the thermoneutral point can be determined based on the balanced chemical reaction for auto thermal

reforming and on heat of reaction. Based on this information an ordinary artisan at the time of the invention would be able to apply well known thermodynamic principles to calculate the thermoneutral point for various fuels." Interview Summary. Applicants respectfully point out that this is beside the point, even if true; neither Equation 5 of Kumar nor Equation 1 of Ahmed is the same as the equation for the thermoneutral point required by claim 1 of the present application. The instant equation for determining the thermoneutral point x_0 employs the ΔH values of the fuel and water, not the O_2:fuel ratio (x). The claimed method further teaches that the optimal value of x lies from about $0.5x_0$ and about $1.5x_0$, a far more precise range than the estimate of "a little higher than that needed for thermoneutrality" as stated in Kumar. Per the Affidavit of Dr. Ahmed, this range was derived from experiment and modeling and could not be calculated *a priori* by one of skill in the art. Affidavit, Paragraph 8. Applicants respectfully submit that Kumar actually teaches away from this range because it indicates that the optimal value of x is always greater than x_0. As Applicants discovered, the method could be used with values of x below x_0 under some conditions.

To the extent that the Examiner is arguing that Ahmed and Kumar provide motivation to derive Applicants' equation and the stated range for x of about $0.5x_0$ to about $1.5x_0$, Applicants respectfully disagree. First, Applicants address the contention that one of ordinary skill in the art at the time of the invention would be motivated to derive Applicants' equation for the thermoneutral point. Per the Affidavit of Dr. Ahmed, an author/co-inventor on each of the cited references, as well as an inventor of the present application, little motivation existed to make such a derivation. Affidavit, Paragraph 1. In the field of reforming processes, there are a number of parameters and conditions that must be accounted for, by a practitioner in the art, in order to run the reaction at an optimal level. Those parameters and conditions include the definition of an appropriate fuel, the classes of materials that will catalyze the reaction of interest, the temperature range within which the reaction is to be run, the range of the oxygen to fuel ratio, and the range of the water to fuel ratio. Affidavit, Paragraph 7. With this many variables to control, the inventors were initially unsuccessful at a modeling approach for the design of an improved partial oxidation process and this led them to a primarily empirical approach. *Id.* It

was not until the inventors – who are also co-inventors of Krumpelt and co-authors of Kumar and Ahmed – realized that the thermoneutral point could serve as a pivot point for determining operating conditions, that they could even begin to develop the claimed method. Affidavit, Paragraph 7. Thus, it was most definitely not obvious to Applicants who are co-inventors and co-authors of Kumpelt, Kumar, and Ahmed, to make the claimed invention. Affidavit, Paragraph 9. If the authors of the cited references did not find the present invention obvious, Applicants respectfully submit that those of ordinary skill in the art would not either.

Moreover, the private sector has begun to employ Applicants' method, providing further support for the nonobviousness of the invention. The reason for this is clear: the present method vastly reduces the work needed to find desirable operating conditions for a partial oxidation process. Affidavit, Paragraph 9.

The claimed invention is a significant addition to the state of the art, through the novel combination of a new way to determine a thermoneutral point (x_o), oxygen to fuel molar ratio (x), water to fuel ratio, a range for those values that encompasses the optimal operating range, the disclosed catalytic materials, and the appropriate fuel. For the reasons above, Applicants respectfully submit that claim 1 is patentably distinct over the cited prior art. Because claims 2-20, 21, and 22, all depend from claim 1, it is submitted that these claims are also patentably distinct over the cited art. Applicants respectfully request that the Examiner withdraw the rejection of claims 1-22.

CONCLUSION

In view of the above amendments and remarks, it is respectfully submitted that all rejections have been overcome and that the Examiner reconsider and withdraw the pending rejections discussed above. The Examiner is cordially invited to telephone the undersigned at the number listed below if the Examiner believes such would be helpful in advancing the application to issuance.

Respectfully submitted,

Date March 1, 2005

By Joseph P Meara

FOLEY & LARDNER LLP
Customer Number: 23524
Telephone: (608) 258-4303
Facsimile: (608) 258-4258

Joseph P. Meara
Attorney for Applicants
Registration No. 44,932